

## CLAIMS

1. A method for correcting a sleep clock of a wireless communications device to account for temperature induced errors by identifying and limiting probable multipath errors, the method comprising operations of:  
responsive to wakeup following a sleep state, measuring a difference between time reference output by a sleep clock and a network time reference and utilizing the difference to compute a current error in the sleep clock's frequency;  
determining whether predetermined criteria are satisfied by aspects of a current error including (1) magnitude and (2) character in relation to errors from previous sleep states;  
bounding a current error unless the criteria is met, the bounding operation comprising: utilizing a predetermined relationship between sleep state duration and predetermined sleep clock error maxima to identify an appropriate maximum error, and limiting magnitude of the current error to the identified maximum error;  
estimating a sleep clock's frequency utilizing inputs including the limited current error;  
utilizing a most recent estimate of the sleep clock's frequency whenever planning a wakeup time.
2. The method of claim 1, the predetermined criteria being met if the current error exceeds a prescribed threshold and has identical mathematical sign as a specified number of consecutively previous errors, and the consecutively previous errors also exceeded the threshold.
3. The method of claim 2, the predetermined criteria also being met if magnitude of the current error does not exceed the threshold.

4. The method of claim 1, where:  
if characteristics of the current error indicate that the current error could be caused by multipath, the bounding operation is performed;  
if characteristics of the current error indicate that the current error is not caused by multipath, the bounding operation is omitted.
5. The method of claim 1, the operation of identifying an appropriate maximum error comprising:  
for sleep states up to a given duration, selecting a predetermined number;  
for sleep states exceeding the given duration, selecting an appropriate value from maxima that increase in a predetermined relationship with increasing sleep state duration.
6. The method of claim 1, the operations further comprising:  
repeating the measuring, determining, bounding, estimating, and utilizing operations for each subsequent sleep state.
7. The method of claim 1, the determining operation comprises:  
if the current error does not exceed a predetermined threshold, concluding that the criteria is met and resetting a counter;  
if the current error exceeds the predetermined threshold, performing operations comprising:  
if the current error varies in sign from a last error, and the last error exceeded the threshold, resetting the counter and concluding that the criteria is not met;  
if the current error does not vary in sign from the last error, and the last error exceeded the threshold, incrementing the counter and determining whether the counter has reached a specified value;  
if yes, concluding that the criteria is met;  
if no, concluding that the criteria is not met.
8. A method for minimizing temperature induced errors experienced by a sleep clock used by a wireless communication device, the method comprising the

following operations, performed responsive to each wakeup following a sleep state:

consulting a time reference output by a wireless communications network,  
comparing the time reference to output of the sleep clock, and  
employing the comparison to compute a current error in sleep clock frequency;

correcting a current error, comprising:

if the current error does not exceed a predetermined threshold, utilizing  
the current error as the corrected error;

if the current error exceeds the predetermined threshold, performing  
operations comprising:

if the current error varies in sign from a last error, and magnitude  
of the last error exceeded the threshold, resetting a counter  
and limiting the current error according to prescribed  
maxima that vary according to sleep state duration;

if the current error does not vary in sign from the last error, and  
the magnitude of the last error exceeded the threshold,  
incrementing the counter and determining whether the  
counter has reached a specified value;

if yes, utilizing the current error as the corrected error;

if no, limiting the current error according to the prescribed  
maxima and utilizing the limited current error as  
the corrected error;

estimating a sleep clock's frequency utilizing inputs including the corrected  
error;

utilizing a most recent estimate of the sleep clock's frequency when planning a  
next wakeup time.

9. A method of correcting a sleep clock of a wireless communications device to account for temperature induced errors by identifying and limiting probable multipath errors, the method comprising operations of:  
responsive to wakeup following a sleep state, utilizing a network time reference to determine a current sleep clock frequency error;

utilizing a predetermined relationship between sleep duration and predetermined sleep clock error maxima to identify an appropriate maximum error corresponding to said sleep state;

identifying a conditioned sleep clock frequency error, which comprises the current sleep clock frequency error limited to the identified maximum error, unless errors of identical mathematical sign and exceeding a prescribed threshold have occurred for a predetermined number of consecutive times including the current error, in which case the conditioned sleep clock frequency error comprises the current sleep clock frequency without being limited;

utilizing information including the conditioned sleep clock frequency error to estimate sleep clock frequency.

10. The method of claim 9, further comprising utilizing information including the estimated frequency to plan a future wakeup time.
11. The method of claim 9, wherein slow current sleep clock frequency errors have one mathematical sign and fast current sleep clock frequency errors have an opposite mathematical sign.
12. A method for correcting sleep oscillator operation of a wireless communications device, comprising operations of:  
estimating sleep oscillator frequency so as to compensate for estimated temperature induced errors;  
in estimating temperature induced errors, treating errors in sleep oscillator frequency as being temperature induced errors, with probable multipath errors being bounded to predetermined sleep clock error maxima corresponding to sleep duration over which the error occurred.
13. The method of claim 12, the treating operation only treating errors whose magnitude exceeds a given threshold, and ignoring sleep clock errors whose magnitude does not exceed the given threshold.

14. The method of claim 12, where the probable multipath errors comprise all errors exceeding a given threshold and not having identical mathematical sign as a predetermined number of consecutively previous errors, where the consecutively previous errors exceeded the given threshold.
15. The method of claim 12, further comprising leaving unbounded such errors that exceed a given threshold and exhibit identical mathematical sign as a given number of consecutively previous errors, where the consecutively previous errors exceeded the given threshold.
16. A signal bearing medium tangibly embodying a program of machine-readable instructions executable by a digital data processor to perform operations for correcting a sleep clock of a wireless communications device to account for temperature induced errors by identifying and limiting probable multipath errors, the operations comprising:
  - responsive to wakeup following a sleep state, measuring a difference between time reference output by the sleep clock and a network time reference and utilizing the difference to compute a current error in the sleep clock's frequency;
  - determining whether predetermined criteria are satisfied by aspects of the current error including (1) magnitude and (2) character in relation to errors from previous sleep states;
  - bounding a current error unless the criteria is met, the bounding operation comprising: utilizing a predetermined relationship between sleep state duration and predetermined sleep clock error maxima to identify an appropriate maximum error, and limiting magnitude of the current error to the identified maximum error;
  - estimating a sleep clock's frequency utilizing inputs including the limited current error;
  - utilizing a most recent estimate of the sleep clock's frequency whenever planning a wakeup time.
17. A signal bearing medium tangibly embodying a program of machine-readable instructions executable by a digital data processor to perform operations for

correcting a sleep clock of a wireless communications device to account for temperature induced errors by identifying and limiting probable multipath errors, the operations comprising:

responsive to wakeup following a sleep state, utilizing a network time reference to determine a current sleep clock frequency error;

utilizing a predetermined relationship between sleep duration and predetermined sleep clock error maxima to identify an appropriate maximum error corresponding to said sleep state;

identifying a conditioned sleep clock frequency error, which comprises the current sleep clock frequency error limited to the identified maximum error, unless errors of identical mathematical sign and exceeding a prescribed threshold have occurred for a predetermined number of consecutive times including the current error, in which case the conditioned sleep clock frequency error comprises the current sleep clock frequency without being limited;

utilizing information including a conditioned sleep clock frequency error to estimate sleep clock frequency.

18. A signal bearing medium tangibly embodying a program of machine-readable instructions executable by a digital data processor to perform operations for correcting sleep oscillator operation of a wireless communications device, the operations comprising:

estimating sleep oscillator frequency so as to compensate for estimated temperature induced errors;

in estimating temperature induced errors, treating sleep oscillator frequency errors as being temperature induced errors, with probable multipath errors being bounded to predetermined sleep clock error maxima corresponding to sleep duration over which the error occurred.

19. Circuitry including multiple interconnected electrically conductive elements configured to perform operations for correcting a sleep clock of a wireless communications device to account for temperature induced errors by identifying and limiting probable multipath errors, the operations comprising:

responsive to wakeup following a sleep state, measuring a difference between time reference output by the sleep clock and a network time reference and utilizing the difference to compute a current error in the sleep clock's frequency;

determining whether predetermined criteria are satisfied by aspects of the current error including (1) magnitude and (2) character in relation to errors from previous sleep states;

bounding a current error unless the criteria is met, the bounding operation comprising: utilizing a predetermined relationship between sleep state duration and predetermined sleep clock error maxima to identify an appropriate maximum error, and limiting magnitude of the current error to the identified maximum error;

estimating a sleep clock's frequency utilizing inputs including the limited current error;

utilizing a most recent estimate of the sleep clock's frequency whenever planning a wakeup time.

20. Circuitry including multiple interconnected electrically conductive elements configured to perform operations for correcting a sleep clock of a wireless communications device to account for temperature induced errors by identifying and limiting probable multipath errors, the operations comprising:
- responsive to wakeup following a sleep state, utilizing a network time reference to determine a current sleep clock frequency error;
- utilizing a predetermined relationship between sleep duration and predetermined sleep clock error maxima to identify an appropriate maximum error corresponding to said sleep state;
- identifying a conditioned sleep clock frequency error, which comprises the current sleep clock frequency error limited to the identified maximum error, unless errors of identical mathematical sign and exceeding a prescribed threshold have occurred for a predetermined number of consecutive times including the current error, in which case the conditioned sleep clock frequency error comprises the current sleep clock frequency without being limited;

utilizing information including the conditioned sleep clock frequency error to estimate sleep clock frequency.

21. Circuitry including multiple interconnected electrically conductive elements configured to perform operations for correcting sleep oscillator operation of a wireless communications device, the operations comprising:
  - estimating sleep oscillator frequency so as to compensate for estimated temperature induced errors;
  - in estimating temperature induced errors, treating sleep oscillator frequency errors as being temperature induced errors, with probable multipath errors being bounded to predetermined sleep clock error maxima corresponding to sleep duration over which the error occurred.
22. A wireless communications device, comprising:
  - a transceiver;
  - a speaker;
  - a microphone;
  - a user interface;
  - data processing equipment, coupled to the transceiver, speaker, microphone, and user interface, and programmed to perform operations for correcting a sleep clock of a wireless communications device to account for temperature induced errors by identifying and limiting probable multipath errors, the operations comprising:
    - responsive to wakeup following a sleep state, measuring a difference between time reference output by the sleep clock and a network time reference and utilizing the difference to compute a current error in the sleep clock's frequency;
    - determining whether predetermined criteria are satisfied by aspects of the current error including (1) magnitude and (2) character in relation to errors from previous sleep states;
    - bounding the current error unless the criteria is met, the bounding operation comprising: utilizing a predetermined relationship between sleep state duration and predetermined sleep clock error



maxima to identify an appropriate maximum error, and limiting magnitude of the current error to the identified maximum error; estimating the sleep clock's frequency utilizing inputs including the limited current error; utilizing a most recent estimate of the sleep clock's frequency whenever planning a wakeup time.

23. A wireless communications device, comprising:
- a transceiver;
  - a speaker;
  - a microphone;
  - a user interface;
- data processing equipment, coupled to the transceiver, speaker, microphone, and user interface, and programmed to perform operations for correcting a sleep clock of a wireless communications device to account for temperature induced errors by identifying and limiting probable multipath errors, the operations comprising:
- responsive to wakeup following a sleep state, utilizing a network time reference to determine a current sleep clock frequency error;
  - utilizing a predetermined relationship between sleep duration and predetermined sleep clock error maxima to identify an appropriate maximum error corresponding to said sleep state;
  - identifying a conditioned sleep clock frequency error, which comprises the current sleep clock frequency error limited to the identified maximum error, unless errors of identical mathematical sign and exceeding a prescribed threshold have occurred for a predetermined number of consecutive times including the current error, in which case the conditioned sleep clock frequency error comprises the current sleep clock frequency without being limited;
  - utilizing information including the conditioned sleep clock frequency error to estimate sleep clock frequency.

24. A wireless communications device, comprising:  
a transceiver;  
a speaker;  
a microphone;  
a user interface;  
data processing equipment, coupled to the transceiver, speaker, microphone, and user interface, and programmed to perform operations for correcting sleep oscillator operation of a wireless communications device, the operations comprising:  
estimating sleep oscillator frequency so as to compensate for estimated temperature induced errors;  
in estimating temperature induced errors, treating sleep oscillator frequency errors as being temperature induced errors, with probable multipath errors being bounded to predetermined sleep clock error maxima corresponding to sleep duration over which the error occurred.
25. A wireless mobile telephone, comprising:  
transceiver means for wireless transmitting and receiving signals;  
speaker means for producing audio output;  
microphone means for a microphone;  
user interface means for receiving user input and providing human-readable output;  
data processing means, coupled to the transceiver means, speaker means, microphone means, and user interface means, for performing operations to correct a sleep clock of a wireless communications device to account for temperature induced errors by identifying and limiting probable multipath errors, the operations comprising:  
responsive to wakeup following a sleep state, measuring a difference between time reference output by the sleep clock and a network time reference and utilizing the difference to compute a current error in the sleep clock's frequency;

determining whether predetermined criteria are satisfied by aspects of the current error including (1) magnitude and (2) character in relation to errors from previous sleep states;

bounding the current error unless the criteria is met, the bounding operation comprising: utilizing a predetermined relationship between sleep state duration and predetermined sleep clock error maxima to identify an appropriate maximum error, and limiting magnitude of the current error to the identified maximum error;

estimating the sleep clock's frequency utilizing inputs including the limited current error;

utilizing a most recent estimate of the sleep clock's frequency whenever planning a wakeup time.

26. A wireless communications device, comprising:

transceiver means for wireless transmitting and receiving signals;

speaker means for producing audio output;

microphone means for a microphone;

user interface means for receiving user input and providing human-readable output;

data processing means, coupled to a transceiver means, speaker means,

microphone means, and user interface means, for performing operations to correct a sleep clock of a wireless communications device to account for temperature induced errors by identifying and limiting probable multipath errors, the operations comprising:

responsive to wakeup following a sleep state, utilizing a network time reference to determine a current sleep clock frequency error;

utilizing a predetermined relationship between sleep duration and predetermined sleep clock error maxima to identify an appropriate maximum error corresponding to said sleep state;

identifying a conditioned sleep clock frequency error, which comprises the current sleep clock frequency error limited to the identified maximum error, unless errors of identical mathematical sign and exceeding a prescribed threshold have occurred for a predetermined number of consecutive times including the current

error, in which case the conditioned sleep clock frequency error comprises the current sleep clock frequency without being limited;

utilizing information including the conditioned sleep clock frequency error to estimate sleep clock frequency.

27. A wireless communications device, comprising:
- transceiver means for wireless transmitting and receiving signals;
  - speaker means for producing audio output;
  - microphone means for a microphone;
  - user interface means for receiving user input and providing human-readable output;
  - data processing means, coupled to a transceiver means, speaker means, microphone means, and user interface means, for performing operations for correcting sleep oscillator operation of a wireless communications device, the operations comprising:
    - estimating sleep oscillator frequency so as to compensate for estimated temperature induced errors;
    - in estimating temperature induced errors, treating sleep oscillator frequency errors as being temperature induced errors, with probable multipath errors being bounded to predetermined sleep clock error maxima corresponding to sleep duration over which the error occurred.